DECLARATION OF MARK J.S. HEATH, M.D.

1. My name is Mark J.S. Heath. I am a Board Certified Anesthesiologist, and have been taught anesthesiology to medical students since 1993. My curriculum vitae is attached to this affidavit as Exhibit A.

2. On October 18, 2013, the Missouri Department of Corrections (MDOC) adopted and promulgated a revised lethal injection protocol. Counsel for several men under sentence of death in the State of Missouri have asked me to review this most recent lethal-injection protocol to determine whether it presents risks of inflicting excruciating pain and suffering on condemned persons during an execution by lethal injection.

3. The document I have reviewed is entitled "Missouri Department of Corrections Preparation and Administration of Chemicals for Lethal Injection," dated October 18, 2013.

4. The prior lethal injection protocol of the MDOC was adopted on September 24th, 2013 .

5. Prior to the protocol of October 2013, protocols from 2006 and from May 2012, August 2013, and September 2013 have also governed the lethal injection procedure.

6. In previous affidavits and in deposition testimony I have outlined serious defects in the MDOC lethal injection procedures. The modifications to the September 24 2013 protocol that are issued in the October 18, 2013 protocol fail to address the defects. Further, the most recent protocol raises new and additional problems. As a result, the protocol that currently governs execution by lethal injection in Missouri presents a substantial and untoward risk of inflicting gratuitous suffering and other problems.

7. The current protocol differs from its predecessors primarily by the elimination of propofol and its substitution of pentobarbital.

8. At present the source of the pentobarbital is not entirely certain, but it appears highly likely that it will be prepared by a compounding pharmacy. This is based on the press release stating that a compounding pharmacy has been included in the execution team. Also, companies that supply pharmaceutical pentobarbital are not allowing their product to be sold to prisons for the purpose of executions.

9. If the pentobarbital is supplied by a compounding pharmacist it will foreseeably not be subjected to the same level of quality control as pharmaceutical grade pentobarbital. This may result in the MDOC being supplied with a preparation that does not have the correct chemical properties. Deviations in chemical properties such as pH, osmolarity, or concentration may be present. Also, problems with contamination by extraneous chemicals and/or microorganisms or microorganismal debris and toxins. Deviations such as those described above may result in a preparation that is painful when injected or is partially or completely ineffective. Sub-potent pentobarbital carries a risk that the prisoner will not be killed by the drug, but will instead be unconscious for an extended period of time while breathing inadequately, before waking up in a permanently brain-damaged state. At that point it would be medically improper to administer more of the purported pentobarbital as directed in section E4 of the new protocol. The failure to induce death would mean that the drug being administered is of unknown identity and strength, and it would be unsound to administer further quantities of an unknown substance.

10. The MDOC has not provided any information about the certification, inspection history, infraction history, or other aspects of the compounding pharmacy. This information would be essential to properly assessing the provenance of the pentobarbital.

11. The MDOC has not provided any information about the training, certification, licensure, infraction history, or other history about the individual or individuals who will perform the compounding of the pentobarbital. This information would be essential to properly assessing the provenance of the pentobarbital.

12. The MDOC has not provided a chemical analysis of the compounded pentobarbital. Such an analysis is easily undertaken, and should be provided. This information would be essential (although not sufficient by itself) to properly assessing the provenance of the pentobarbital.

13. In the current protocol the medical team is still at liberty to insert a central venous line as the primary IV line. This deviates

from the standard of other states, which either prohibit the use of central lines, or permit the use of central lines only as a "backup" in the event that peripheral IV access cannot be obtained.

14. Based on statements by M3, the Board Certified anesthesiologist who participates in the executions, it appears that his preference is to insert a central venous catheter. This plan puts the prisoner at risk because the placement of central venous catheters is unnecessary and is gratuitously painful and invasive and risky.

15. As I have described in several prior declarations, the placement of central venous catheters is associated with severe complications (described below) that can be extremely painful. Because these complications are foreseeable (and when conducted on a large series of patients or prisoners are inevitable), it is essential that central venous catheter insertion only be undertaken when necessary and only in the presence of immediately available equipment, supplies, and medication to treat these complications. At present, there is no evidence that M3 or the MDOC have such equipment, supplies, and medication immediately available.

16. The hazards and complications of obtaining central venous access have been detailed in prior affidavits filed in this litigation. Specifically, central IV access is inherently more invasive and painful than peripheral IV access, and is associated with much more serious and painful complications. Well-recognized complications of central IV access procedures include:

a) Tension pneumothorax, in which air enters the space between the lung and the chest wall, compressing and collapsing the lung, and producing suffocation and hemodynanic collapse.

b) Perforation/laceration of large central blood vessels and perforation of the heart, resulting in severe and fatal internal or external hemorrhage.

c) Perforation/laceration of the carotid artery in the neck, causing severe stroke / brain damage, and/or causing formation of a hematoma (mass of blood) in the neck which can obstruct the trachea and cause death by suffocation.

d) Pain.

e) Cardiac arrhythmia, caused by the guide wire irritating the electrically excitable membranes in the heart, resulting in hemodynamic collapse and death.

f) Perforation of the bowel or bladder.

The above complications can occur when the patient is cooperative and motionless, and are more likely to occur if the patient (or prisoner) is uncooperative and struggling.

17. In summary, this most recent (October 18, 2013) protocol is, like its predecessors, replete with flaws that present a substantial risk of causing severe and unacceptable levels of pain and suffering during the execution.

18. All of the foregoing findings, opinions, and conclusions are made to a reasonable degree of scientific and medical certainty.

19. I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 7th, 2013

MARK J.S. HEATH, M.D.

Assistant Professor of Clinical

Anesthesiology

College of Physicians & Surgeons

Columbia University

New York, New York 10024

Curriculum Vitae

1) Date of preparation: March 8, 2013

2) Name: Mark J. S. Heath

Birth date: March 28, 1960
Birthplace: New York, NY
Citizenship: United States, United Kingdom

3) Academic Training:

Harvard University	B.A., Biology, 1983
University of North Carolina, Chapel Hill	M.D., 1987
Medical License	New York: 177101-1

4) Traineeship:

1987 – 1988 Internship, Internal Medicine, George Washington University Hospital, Washington, DC.

1988 – 1991 Residency, Anesthesiology, Columbia College of Physicians and Surgeons, New York, NY

1991 – 1993 Fellowship, Anesthesiology, Columbia College of Physicians and Surgeons, New York, NY

5) Board Qualification:

Diplomate, American Board of Anesthesiology, October 1991.
Diplomate National Board of Echocardiography Perioperative Transesophageal Echocardiography 2005. (PTEeXAM 2001).

6) Military Service: None

7) Professional Organizations:

None

8) Academic Appointments:

1993 – 2002 Assistant Professor of Anesthesiology, Columbia University, New York, NY

2002 - present Assistant Professor of Clinical Anesthesiology, Columbia University, New York, NY

9) Hospital/Clinical Appointments:

1993 – present Assistant Attending Anesthesiologist, Presbyterian Hospital, New York, NY.

10) Honors:

Magna cum laude, Harvard University
Alpha Omega Alpha, University of North Carolina at Chapel Hill
First Prize, New York State Society of Anesthesiologists Resident Presentations, 1991

11) Fellowship and Grant Support:

Foundation for Anesthesia Education and Research, Research Starter Grant Award, Principal Investigator, funding 7/92 - 7/93, $15,000.

Foundation for Anesthesia Education and Research Young Investigator Award, Principal Investigator, funding 7/93 - 7/96, $70,000.

NIH KO8 "Inducible knockout of the NK1 receptor"
Principal Investigator, KO8 funding 12/98 - 11/02,
$431,947 over three years
(no-cost extension to continue through 11/30/2002)

NIH RO1 "Tachykinin regulation of anxiety and stress responses"
Principal Investigator, funding 9/1/2002 – 8/30/2007
$1,287,000 over 5 years

12) Departmental and University Committees:

Research Allocation Panel (1996 – 2001)

Institutional Review Board (Alternate Boards 1-2, full member Board 3) (2003 - present)

13) Teaching:

Lecturer and clinical teacher: Anesthesiology Residency Program, Columbia University and Presbyterian Hospital, New York, NY

Advanced Cardiac Life Support Training

Anesthetic considerations of LVAD implantation. Recurrent lecture at Columbia University LVAD implantation course.

Invited Lectures:

NK1 receptor functions in pain and neural development, Cornell University December 1994

Anxiety, stress, and the NK1 receptor, University of Chicago, Department of Anesthesia and Critical Care, July 2000

Anesthetic Considerations of LVAD Implantation, University of Chicago, Department of Anesthesia and Critical Care, July 2000

NK1 receptor function in stress and anxiety, St. John's University Department of Medicinal Chemistry, March 2002

Making a brave mouse (and making a mouse brave), Mt.Sinai School of Medicine, May 2002

NK1 receptor function in stress and anxiety, Visiting Professor, NYU School of Medicine, New York, New York. October 2002.

Problems with anesthesia during lethal injection procedures, Geneva, Switzerland. Duke University School of Law Conference, "International Law, Human Rights, and the Death Penalty: Towards an International Understanding of the Fundamental Principles of Just Punishment". July 2002.

Anesthetic Depth, Paralysis, and other medical problems with lethal injection protocols: evidence and concerns, Federal Capital Habeas Unit Annual Conference, Jacksonville, Florida. May 2004.

Medical Scrutiny of Lethal Injection Procedures. NAACP Legal Defense Fund, Airlie Conference Center, Warrenton, Virginia. July 2004.

Ethical Issues of Lethal Injection Procedures Advanced Criminal Law Seminar 2005, Fordham University School of Law, March 2005

Execution Pharmacology: Lethal Injection and the Law. CUNY Law School. April 2005.

Medical Scrutiny of Lethal Injection Procedures, Update 2005. NAACP Legal Defense Fund, Airlie Conference Center, Warrenton, Virginia, July 2005.

Medical *Scrutiny of Lethal Injection Procedures,* Update 2006. NAACP Legal Defense Fund, Airlie Conference Center, Warrenton, Virginia. July 2006.

Medical Scrutiny of Lethal Injection Procedures Advanced Criminal Law Seminar, Fordham University School of Law, January 2007

EEG and consciousness during execution by lethal injection. Neuroethics Seminar, Columbia University. February 2007.

Problematic executions. Physicians for Human Rights, Princeton University. April 2007.

Medical *Scrutiny of Lethal Injection Procedures.* Update 2007. NAACP Legal Defense Fund, Airlie Conference Center, Warrenton, Virginia. July 2007

Technical Challenges to Execution by Lethal Injection. Department of Medicine Grand Rounds, Columbia University, September 2007.

Induced Participation: Medical Professionals and Execution by Lethal Injection. 4th Year Medical Student Ethics discussion. October 2007.

Physician Participation in Lethal Injection. Physicians for Human Rights Invited Speaker. Mount Sinai School of Medicine, November 2007.

Execution by Lethal Injection: Medical Update. Advanced Criminal Law Seminar, Fordham University School of Law, January 2008

Lethal Injection – a field report. The Supreme Court and the Legal, Medical, and Ethical Challenges to Execution by Lethal Injection, Columbia University Symposium. January 2008

Medical Mechanics of Lethal Injection. University of Michigan Law School, Ann Arbor. March 2008.

Current Controversies in Execution by Lethal Injection. *Fordham* Urban *Law*. Journal *Symposium*, The *Lethal Injection*

Debate: *Law* and Science, *Fordham* University. School of *Law. March 2008*

Medical and Legal Challenges to Execution by Lethal Injection. Cornell Law School. April 2008.

Lethal Injection: both a medical and a non-medical procedure. University of North Carolina, Chapel Hill, April 2008

Execution by lethal injection: Medical mechanics and ethics, National Institutes of Health Grand Rounds, May 2008

Anesthesia, Consciousness, and Execution by Lethal Injection. Psychiatry, Law, and Ethics Seminar. Columbia University Medical Center. October 2008.

Ethical dimensions of physician participation in execution by lethal injection. American Society for *Bioethics* & Humanities. October 2008.

Update on Lethal Injection. Physicians for Human Rights, Columbia University Medical Center. November 2008.

Execution by lethal injection: Medical mechanics and ethics. Physicians for Human Rights, Columbia Unversity Medical Center. April 29, 2010.

Fordham University School of Law. Lethal injection, an Update. April 5, 2011.

Albert Einstein College of Medicine. Execution by lethal injection: Medical mechanics and ethics April 25, 2012.

Albert Einstein College of Medicine. Lethal injection: Participation of Health Care Providers and Ethical Considerations. January 9. 2013.

14) Requested/Invited Live Testimony before Governmental Bodies regarding Lethal Injection:

Nebraska Senate Judiciary Committee, Omaha. November 2002

Maryland House Judiciary Committee, Annapolis. February 2007

Maryland Senate Judiciary Committee, Annapolis. February 2007

Pennsylvania House Judiciary Committee, Harrisburg. March 2006

South Dakota House Committee, Pierre. February 2007

Nebraska Senate Judiciary Committee, Omaha. January 2009

Florida: The Governor's Commission on Administration of Lethal Injection, Tampa. February 2007

House of Lords, London, U.K. Regarding legislation governing the exportation of drugs used for lethal injection. February 2010

15) Grant Review Committees: None

16) Publications:

Original peer reviewed articles

Heath, M.J.S. (2008). Revisiting physician involvement in capital punishment: medical and nonmedical aspects of lethal injection. Mayo Clinic Proceedings. Jan;83(1):115-6

Heath, M. J. S., Stanski DR, Pounder DJ. Inadequate Anesthesia in Lethal Injection for Execution. Lancet, 366(9491) 1073-4, correspondence. 2005

Santarelli, L., Gobbi, G., Debs, P.C., Sibille, E. L., Blier, P., Hen, R., **Heath, M.J.S.** (2001). Genetic and pharmacological disruption of neurokinin 1 receptor function decreases anxiety-related behaviors and increases serotonergic function. **Proc. Nat. Acad. Sci**., 98(4), 1912 – 1917.

King, T.E. $^{\delta}$, **Heath M. J. S$^{\delta}$.**, Debs, P, Davis, MB, Hen, R, Barr, G. (2000). The development of nociceptive responses in neurokinin-1 receptor knockout mice. Neuroreport.;11(3), 587-91 δ authors contributed equally to this work

Heath, M. J. S., Lints, T., Lee, C. J., Dodd, J. (1995). Functional expression of the tachykinin NK_1 receptor by floor plate cells in the embryonic rat spinal cord and brainstem. **Journal of Physiology** 486.1, 139 -148.

Heath, M. J. S., Womack M. D., MacDermott, A. B. (1994). Subsance P elevates intracellular calcium in both neurons and glial cells from the dorsal horn of the spinal cord. **Journal of Neurophysiology** 72(3), 1192 - 1197.

McGehee, D. S., **Heath, M. J. S**., Gelber, S., DeVay, P., Role, L.W. (1995) Nicotine enhancement of fast excitatory synaptic transmission in the CNS by presynaptic receptors. **Science** 269, 1692 - 1696.

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Kyrozis A., Goldstein P. A., **Heath, M. J. S.**, MacDermott, A. B. (1995). Calcium entry through a subpopulation of AMPA receptors desensitized neighboring NMDA receptors in rat dorsal horn neurons. **Journal of Physiology** 485.2, 373 - 381.

McGehee, D.S., Aldersberg, M. , Liu, K.-P., Hsuing, S., **Heath, M.J.S.** , Tamir, H. (1997). Mechanism of extracellular Ca^{2+}-receptor stimulated hormone release from sheep thyroid parafolicular cells. **Journal of Physiology**: 502,1, 31 - 44.

Kao, J., Houck, K., Fan, Y., Haehnel, I., Ligutti, S. K., Kayton, M. L., Grikscheit, T., Chabot, J., Nowygrod, R., Greenberg, S., Kuang, W.J., Leung, D. W., Hayward, J. R., Kisiel, W., **Heath, M. J. S.**, Brett, J., Stern, D. (1994). Characterization of a novel tumor-derived cytokine. **Journal of Biological Chemistry** 269, 25106 - 25119.

Dodd, J., Jahr, C.E., Hamilton, P.N., **Heath, M.J.S.**, Matthew, W.D., Jessell, T.M. (1983). Cytochemical and physiological properties of sensory and dorsal horn neurons that transmit cutaneous sensation. **Cold Spring Harbor Symposia of Quantitative Biology** 48, 685 -695.

Pinsky, D.J., Naka, Y., Liao, H., Oz, M. O., Wagner, D. D., Mayadas, T. N., Johnson, R. C., Hynes, R. O., **Heath, M.J.S**., Lawson, C.A., Stern, D.M. Hypoxia-induced exocytosis of endothelial cell Weibel-Palade bodies. **Journal of Clinical Investigation** 97(2), 493 - 500.

Heath, M.J.S. (2008). Revisiting Physician Involvement in Capital Punishment: Medical and Nonmedical Aspects of Lethal Injection. Mayo Clinic Proceedings 83(1):115-117.

Case reports none

Review, chapters, editorials

* **Heath, M. J. S.**, Dickstein, M. L. (2000). Perioperative management of the left ventricular assist device recipient. Prog Cardiovasc Dis.;43(1):47-54.

* Dickstein, M.L., Mets B, **Heath M.J.S**. (2000). Anesthetic considerations during left ventricular assist device implantation. Cardiac Assist Devices pp 63 – 74.

* **Heath, M. J. S.** and Hen, R. (1995). Genetic insights into serotonin function. **Current Biology** 5.9, 997 -999.

* **Heath, M.J.S.**, Mathews D. (1990). Care of the Organ Donor. **Anesthesiology Report** 3, 344-348.

* **Heath, M. J. S.,** Basic physiology and pharmacology of the central synapse. (1998) **Anesthesiology Clinics of North America** 15(3), 473 - 485.

Abstracts

Heath, M.J.S. (2010). Thiopental Toxicology in Execution by Lethal Injection: The Role of Post-Mortem Redistribution Anesthesiology 95:A-868.

Heath, M.J.S., Analysis of EKG recordings from executions by lethal injection. Canadian Society of Anesthesiology Winter Meeting, February 2006.

Heath, M.J.S., Analysis of postmortem thiopental in prisoners executed by lethal injection IARS Congress 2005.

Heath, M.J.S., Davis, M., Santarelli L., Hen H. (2002). Gene targeting of the NK1 receptor blocks stress-evoked induction of c-Fos in the murine locus coeruleus. IARS American-Japan Congress A-15.

Heath, M.J.S., Davis, M., Santarelli L., Hen H. (2002). Gene targeting of the NK1 receptor blocks stress-evoked induction of c-Fos in the murine locus coeruleus. Anesthesiology 95:A-811.

Heath, M.J.S., Davis, M., Santarelli L., Hen H. (2002). Expression of Substance P and NK1 Receptor in the Murine Locus Coeruleus and Dorsal Raphe Nucleus. Anesthesia and Analgesia 93; S-212

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Heath, M.J.S., Santarelli L, Hen H. (2001) The NK1 receptor is necessary for the stress-evoked expression of c-Fos in the paraventricular nucleus of the hypothalamus. Anesthesia and Analgesia 92; S233.

Heath, M.J.S., Santarelli L, Debs P, Hen H. (2000). Reduced anxiety and stress responses in mice lacking the NK1 receptor. Anesthesiology 93: 3A A-755.

Heath, M.J.S., King, T., Debs, P.C., Davis M., Hen R., Barr G. (2000). NK1 receptor gene disruption alters the development of nociception. Anesthesia and Analgesia; 90; S315.

Heath, M.J.S., Lee, J.H., Debs, P.C., Davis, M. (1997). Delineation of spinal cord glial subpopulations expressing the NK1 receptor. Anesthesiology; 87; 3A; A639.

Heath, M.J.S., MacDermott A.B. (1992). Substance P elevates intracellular calcium in dorsal horn cells with neuronal and glial properties. Society for Neuroscience Abstracts; 18; 123.1.

Heath, M.J.S., Lee C.J., Dodd J. (1994). Ontogeny of NK1 receptor-like immunoreactivity in the rat spinal cord. Society for Neuroscience Abstracts; 20; 115.16.

Heath, M.J.S., Berman M.F. (1991) Isoflurane modulation of calcium channel currents in spinal cord dorsal horn neurons. Anesthesiology 75; 3A; A1037.